(b) about 5 atom % to about 60 atom % of at least one element selected from the group consisting of rhenium, tungsten, ruthenium, and combinations thereof;

(c) about 1 atom % to about 35 atom % of at least one element selected from the group consisting of nickel, cobalt, iron, and combinations thereof; and

(d) about 0.1 atom % to about 5 atom % of at least one element selected from the group consisting of zirconium, titanium, hafnium, silicon, boron, carbon, tantalum, ruthenium, molybdenum, and yttrium,

wherein, for the maximum level of chromium present, the sum of (a), (b), (c), and (d) is no greater than 100%.

REMARKS

Restriction Requirement

Claims 1-47 were originally submitted as part of the present application. They were made subject to a Restriction Requirement, resulting in two Groups: Claims 1-40 and claims 41-47. On August 6, 2002, a provisional election of group I (claims 1-40) was made by Applicant, with traverse. Applicant now affirms that election, and acknowledges the Examiner's reference to 37 CFR 1.142(b), regarding inventorship.

However, Applicant also continues to maintain that all of the originally-presented claims are part of one inventive concept, and can be examined as such. Claims 1-40 are directed to a product, i.e., a barrier coating material, as well as a multilayer article in which that material is incorporated.

Claims 41-47 cover a method for preventing aluminum migration through regions of the article. The materials of claims 1-40, i.e., the barrier coating constituents, are identical to the barrier layer materials of claims 41-47. Moreover, the claimed process depends specifically on the presence of the claimed barrier material.

It is the Examiner' s view that the claimed product may be made by a materially different process. A casting process, using a mold, is provided as an example. However, Applicant submits that the illustration offered by the Examiner still includes the step of "disposing a diffusion barrier layer between the substrate and the coating". (Note, for example, that claim 41 is not restricted to any particular technique for applying the coating layers to the substrate.). Therefore, Applicant believes that the subject matter of Groups I and II is not distinct enough to warrant a Restriction Requirement.

Moreover, Applicant does not believe that Groups I and II have achieved "a separate status in the art", in a manner which mandates Restriction. The Examiner has recited different classes and subclasses for Groups I and II. However, the primary subject matter of all of the claims is the composition of the barrier layer. Applicant believes that such a common feature would result in relevant prior art being cross-referenced in both classification areas. In other words, "double searching" would not seem to be required, and the searching burden on the Examiner does not seem to be excessive. Applicant thus requests that the Restriction Requirement be withdrawn. In the interim, Applicant has canceled claims 41-47. The cancellation is being undertaken solely for the purpose of the fee calculation, and not to surrender any subject matter. The claims will be re-entered if the Examiner reconsiders the Restriction Requirement.

Claim Rejections - 35 USC 102

The issue of anticipation under Section 102 can be reviewed more efficiently if the expression of the constituent-ranges for the compositions is standardized. The present inventors have expressed the composition of the clamed barrier layer in "atom percent", which is often a preferred type of unit for alloy "design" in this area. Conversion of the atom % values to weight percent can readily be carried out, using the atomic weights for each element. As an illustration for a given composition having constituents A, B, and C, in atom percent:

Weight % of A = (atom % of A) (atomic weight of A) / the sum (total) of :

[(atom % of A) (atomic weight of A) +
(atom % of B) (atomic weight of B) +
(atom % of C) (atomic weight of C)...]

The weight percent for components B and C (or however many components are present) can be calculated in the same manner. The value of the denominator in the illustrated equation (or for any composition being converted) will remain the same in each case. An example of a calculation for claim 1 (as originally filed) is as follows, using chromium with rhenium:

Atom %'s in Claim 1 (Assumption of Cr level of 40% if Re is 60%)

Cr	Re
95%	5%
40%	60%

Chromium atomic weight: 52.0
Rhenium atomic weight 186.2

Conversion for higher level of Cr:

95(52) + 5(186.2) = (The "divisor")
4940 + 931 = 5871

Then, 4940/5871 x 100 = 84.1 weight % Cr
931/5871 x 100 = 15.9 weight %. Re

Conversion for lower level of Cr (and, thus, higher level of Re):

40(52) + 60(186.2) = (The "divisor")
2080 + 11,172 = 13,252

Then, 2080/13,252 x 100 = 15.7 weight % Cr
11,172/13,252 x 100 = 84.3 weight %. Re

All of the other conversions would follow the same procedure. A few of them are listed below, to facilitate discussion. In the case of claim 1, Applicant has provided the conversion for chromium with rhenium or with ruthenium. (The ranges for tungsten would be similar to those of rhenium, in view of the similarity in atomic weights).

Chromium and Rhenium

Element	Atom Percent Range	Weight Percent Range
Chromium	40 - 95	15.7 - 84.1
Rhenium	5 - 60	15.9 - 84.3

Chromium and Ruthenium

Element	Atom Percent Range	Weight Percent Range
Chromium	40 - 95	25.5 - 90.7
Ruthenium	5 - 60	9.3 - 74.5

An exemplary conversion is offered for claim 2:

Chromium, Rhenium, and Nickel

Element	Atom Percent Range	Weight Percent Range
Chromium	15 - 94	5.8 - 83.2
Rhenium	5 - 60	15.8 - 83.3
Nickel	1 - 35	1.0 - 16.9

An exemplary conversion is offered for claim 3, as well:

Chromium, Rhenium, and Aluminum

Element	Atom Percent Range	Weight Percent Range
Chromium	15 - 94	6.2 - 83.6
Rhenium	5 - 60	15.9 - 84.4

Aluminum	1 - 35	0.5 - 8.6

Applicant emphasizes that the choice of particular elements for the above conversions is merely exemplary, and not meant to indicate particular preferences, unless otherwise noted herein. The conversions should, however, facilitate the analysis under Section 102. (More conversions can be provided if the Examiner wishes).

Claims 1, 2, 5, 7, 10, 21, 23, 24-33, 37, 39 and 40 have been rejected under U.S.C. 102(b), as being anticipated by Chesnes, U.S. Patent 5,916,518. Chesnes is directed to braze alloy compositions. A number of specific compositions are described in the patent, e.g., see columns 5-7. As an example, the composition of col. 6, lines 35-48 includes, in weight % ("wt.%"): 10.5% Ni, 23% Cr, 1.5% Al, 1.75% Ti, 3% W, 1% Re, 6% Ta, 0-40 % Pt, 0-40% Pd, 0-0.55% C, 1.5% B, and 5% Si, with cobalt constituting the balance. The Examiner indicates (from cols. 5-6) that chromium can be present at a level of up to 40 wt.%; rhenium at a level of up to 15 wt.%; aluminum at a level of up to 12 wt.%; tungsten at a level of up to 15 wt.%; and nickel at a level of up to 10 wt.%.

A rejection of the claims under 35 U.S.C. 102(b) requires that each limitation of the claims be disclosed in the reference. In the present instance, Chesnes fails to contain all of the limitations present in Applicant's claim 1. With reference to the weight percentage ranges set forth above, Applicant notes that there is some overlap in the level of chromium. However, the level of rhenium and tungsten in Chesnes (i.e., component (b) of the claimed invention) is too low. The patent calls for a maximum of 15 wt.% for each element, while the minimum for rhenium and tungsten in pending claim 1 (as filed) is 15.9 wt.% and 15.7 wt.%, respectively. (The calculation for rhenium is provided above; tungsten's calculation is very similar). Moreover, the Chesnes reference fails to disclose the presence of the third possibility for

component (b), i.e., ruthenium. Furthermore, the patent does not describe a "barrier coating material".

In regard to claim 2, there appears to be some overlap in regard to the nickel level in Chesnes. However, the limitations regarding Re, W, or Ru are still not met. The same holds true for the narrower ranges recited in claims 5 and 10. Chesnes also fails to anticipate claim 7. While there may be some overlap in regard to Ni/Co/Fe, the other limitation in the base claim (re Re/W/Ru) is still not met.

Chesnes also fails to describe the articles taught in claims 21, 23-33, 37, 39 and 40. As an example, the patent describes a metal-based substrate, but fails to describe a diffusion barrier layer - let alone one with the composition of claim 1. Moreover, while the reference describes various types of protective coatings for substrates, e.g., "MCrAl(X)" and ceramic coatings (col. 14, lines 57-65), it fails to disclose a coating structure which includes the barrier coating of the present invention. Thus, Applicant submits that Chesnes does not anticipate the claims at issue.

Claims 1-4 and 10-12 are rejected under U.S.C. 102(b), as being anticipated by Schmitz et al, U.S. Patent 5,993,980 ("Schmitz"). Schmitz describes a protective coating which includes a heat insulation layer. That layer includes the following primary components, expressed in weight %: 5-20% Re, 15-35% Cr, and 7-18% Al, with most of the balance consisting of cobalt and/or nickel (col. 3, lines 33-47). A variety of optional components can also be included, such as tungsten, at up to 12 wt.%.

In comparison to the present invention, Schmitz fails to disclose a barrier layer. Instead, Schmitz is describing a conventional "MCrAlY"-type coating which promotes adhesion between a substrate and a typical, ceramic top layer (See col. 3, lines 21-32).

Rhenium is added to the coating of Schmitz, to enhance fatigue properties, as well as oxidation- and corrosion resistance (col. 4, lines 3-9). There appears to be a small amount of overlap between Schmitz and the present invention, in terms of chromium and the rhenium levels. However, Applicant has amended claim 1, so that the minimum level of rhenium for certain embodiments is now 15 atom %. This amount corresponds to about 38.7 wt.% - well above the maximum level of Schmitz. (The undersigned would be happy to provide the Examiner with the conversion-calculation, if requested. Other changes to claim 1 are discussed below.). Support for the new lower limit of rhenium can be found, for example, in paragraph 19 of the specification, third sentence. Applicant also wishes to emphasize that the modified language of claim 1, component (b), is still intended to cover the combination of rhenium with tungsten or ruthenium, or any combination thereof.

The level of tungsten (12 wt.%) in the Schmitz patent is lower than that required for the present invention. Moreover, Schmitz does not appear to disclose ruthenium. Furthermore, the differences noted above are also relevant to claims 10-12, which are primarily directed to more specific levels of rhenium. The lowest amount of Re present in Applicant's compositions will still be considerably greater than that of Schmitz, regardless of whether aluminum and Ni/Co/Fe components are also present (claims 11 and 13). Applicant thus submits that Schmitz does not anticipate the claims at issue.

Claims 1-12 stand rejected under U.S.C. 102(b), as being anticipated by Czech et al, U.S. Patent 5,582,635 ("Czech '635"). Chech '635 describes a protective coating consisting essentially of the following primary components, expressed in weight %: 25-40% Ni, 28-32% Cr, 7-9% Al, and

0.5-2% silicon. Other optional components can be present as well, such as Re and W (both at 0-15 wt.%). (See col. 2, lines 9-29).

As in the two other references discussed above, Chech '635 fails to meet all of the limitations of the present invention. Again, there is some slight overlap in the amount of rhenium, but that overlap is eliminated by the amendment to claim 1. The level of tungsten (15% maximum) is below that of the present invention, as discussed previously in regard to the Chesnes patent. Moreover, Chech '635 fails to mention the presence of ruthenium for the coatings.

The differences noted above also serve to distinguish dependent claims 2-12 from Chech '635. Furthermore, the level of nickel in the patent is higher than that specified for claim 2 of the present invention (1.0 - 16.9 wt.% in Applicant's exemplified range, noted above). The same should be the case for alternative elements cobalt or iron in claim 2, which have atomic weights fairly close to that of nickel. Thus, Applicant submits that claims 1-12 are patentable over Chech '635.

Claims 1, 3, 4, 13, 14, 16 and 17 are rejected under U.S.C. 102(b), as being anticipated by Jackson, U.S. Patent 4,980,244. Jackson describes a composition consisting essentially of chromium, ruthenium, and aluminum. The components are present in proportions set forth within the bounds of curve A, as shown in the triaxial plot of FIG. 5 (see claim 1; col. 2, lines 60-64). A review of the plot appears to show the following approximate ranges for the components, in atom %: 32 at.% to 63 at.% chromium; 18 at.% to 35 at.% ruthenium; and 19 at.% to 35 at.% aluminum. As the Examiner can see, the tables in column 6 (as well as the tables in column 7) provide some conversions for exemplary compositions of Jackson.

It is clear that Jackson fails to describe compositions which contain rhenium or tungsten. In fact, the compositions are generally restricted to the three components set forth above, although the patent alludes to compositions which may contain iron as well (e.g., Table III). Jackson also fails to describe the presence of a "barrier layer", as recited in the present claims. Moreover, the patent fails to describe Applicant's article, although the article claims do not appear to be at issue here.

However, Jackson does disclose compositions which overlap those of the present invention, in terms of ruthenium and aluminum content. In order to reduce issues in prosecution, Applicant has deleted ruthenium from claim 1, and recited the element in new claim 49. The new claim recites combinations of chromium and ruthenium in ranges previously set forth in claim 1. The claim further includes about 1 to 15 atom % aluminum. Such a range for aluminum is never disclosed in Jackson, which appears to have a minimum level of 19 atom %. Support for Applicant's range of aluminum is found, for example, in paragraph 22 of the specification, line 9. Thus Applicant submits that new claim 49 is patentable over Jackson.

The attention of the Examiner is briefly directed to the last phrase in claim 49, which indicates that the sum of the components must equal 100%. In other words, the phrase clarifies the fact that chromium cannot exceed 94 atom %, if ruthenium and aluminum are present at 5 atom % and 1 atom %, respectively. Applicant also notes that the claim, while distinguishing over Jackson, is still open-ended, allowing for the presence of other components. (The same type of phrasing has also been added to several of the new claims discussed below).

Claims 1-12 stand rejected under U.S.C. 102(b), as being anticipated by Czech et al, U.S. Patent 5,273,712 ("Czech '712"). The patent describes a protective coating for metal components. In general terms, the

coating contains, in weight percent: 1-20% Re, 15-50% Cr, 0-15% Al, and most of the balance consisting of Fe, Ni, or Co (col. 1, line 59- col. 2, line 19). A variety of elective components can also be present, such as silicon, yttrium, tungsten (0-12%), and zirconium. Moreover, a restriction on the combined quantity of chromium and aluminum is also described.

Clearly, Chech '712 mentions a coating composition which includes chromium, rhenium, and optionally, tungsten. However, the level of tungsten is lower than that specified for the present invention. Moreover, the level of rhenium is also below that recited in amended claim 1. The level of nickel is generally higher than that of the present invention, although there may be a slight amount of overlap.

In regard to Applicant's claim 3, there is some overlap in the respective levels of aluminum. However, that claim, like others (as filed), also requires relatively high levels of rhenium, tungsten, or ruthenium. The Chech '712 patent discloses insufficient levels of tungsten for the present invention, and also fails to even mention the presence of ruthenium. Furthermore, Chech '712 does not disclose a composition in the form of a barrier layer, as in the present invention. Applicant thus requests that this anticipation-rejection be withdrawn.

Claims 1-7 stand rejected under U.S.C. 102(e), as being anticipated by Nazmy et al, U.S. Patent 6,245,447 ("Nazmy"). This patent describes an iron-aluminide coating being used as a bonding layer. The coating includes, by weight: 5-35% Al, 15-25% Cr, 0.5-10% Mo, W, Ta, and/or Nb; 0-0.3% Zr, 0-1% B, and 0-1% Y, with the remainder being iron (col. 1, lines 37-48).

Applicant emphasizes that Nazmy is clearly outside the scope of the present invention, when the formulations are compared with common units, i.e., weight percent. The level of tungsten is too low for the present invention. Moreover, the patent fails to disclose the presence of ruthenium or rhenium, and has nothing to do with a barrier layer.

A brief comment relative to several of the dependent claims is also in order. While there is overlap in the level of aluminum, the compositions of Nazmy do not appear to contain nickel. Moreover, they generally require large amounts of iron (e.g., see the tables in columns 1-3), which appear to be above the maximum for the present invention. For these reasons, Nazmy clearly does not anticipate the present invention.

Claims 1, 10, 13-15, 18-22, 26-33, and 35-39 are rejected under U.S.C. 102(e), as being anticipated by Spitsberg et al, U.S. Patent 6,306,524 ("Spitsberg"). This patent describes a coating used over a superalloy substrate. The coating includes a diffusion barrier layer as an intermediate layer between the substrate and an overlying protective coating. (A ceramic-type thermal barrier coating may also be employed as the top layer). The protective coating has a high content of aluminum (col. 3, lines 30-32). The diffusion barrier layer has a low diffusion permeability for aluminum from the coating. It may also have a low diffusion permeability for refractory elements which would migrate from the substrate.

A variety of coating compositions are described in the patent. (Note that, in this instance, they are expressed in atom percent, as in Applicant's claims). Most of the compositions contain very low levels of chromium, e.g., 5 atom % or less (col. 6, Table 1). However, several of the compositions which happen to be listed in that table include higher chromium levels, i.e., see alloys DB 12, 22, and 26. Moreover, DB 22 contains 15 atom % ruthenium, while DB 26 contains 35 atom % rhenium, which both appear to

be within the scope of the present invention. Spitsberg also describes articles which are similar to those of the present invention, in terms of substrates and overlying protective coatings.

However, Spitsberg does not disclose tungsten in a composition like that of the present invention, e.g., in the Table 1 compositions of the patent, containing higher levels of chromium. Moreover, Spitsberg fails to disclose nickel, cobalt, or iron in such a composition. Furthermore, Spitsberg contains no disclosure of aluminum in any of the "higher-chromium" compositions.

It should be apparent that there are certainly differences between the teachings of Spitsberg and the present invention. However, Applicant is willing to advance prosecution by swearing behind the reference, with the attached Declaration under Rule 131. The Declaration is presently unsigned, but an executed copy can be submitted shortly. The exhibits provide evidence of the claimed invention being reduced to practice before the filing date of Spitsberg, March 24, 1999. Applicant submits that the Declaration should remove the reference from consideration in this context.

Claims 21 and 23-40 have been rejected under 35 U.S.C. 103(a), as being unpatentable over Czech '635, in view of Spitsberg et al, U.S. 6,306,524. Although this is not structured as an "obviousness-type" double patenting rejection, Applicant questions the status of Spitsberg as a reference. The question relates to the Rule 131 Affidavit submitted herewith, and to the possibility that the reference can alternatively be removed by way of Rule 130. (The present application and Spitsberg are commonly owned, and the patent is not prior art under 35 U.S.C. 102(b)). The undersigned would appreciate discussing this issue with the Examiner. In the meantime, however, Applicant will also reply substantively to the Section 103 rejection.

In brief, one embodiment of the present invention is directed to a barrier coating material based on chromium and at least one of rhenium, tungsten, or ruthenium. Other components are present when certain end uses are contemplated for the coating material. For example, the superalloy elements, nickel, cobalt, or iron, are sometimes included, as is aluminum.

Another important embodiment of the invention is directed to an article which includes the barrier layer, e.g., a turbine engine part. As described in paragraphs 12 and 13 of the specification, the barrier layer is important for several functions - especially under high temperature conditions. For example, it prevents the substantial migration of aluminum from an aluminum -rich overlayer into the substrate. In this manner, the detrimental effects of diminished aluminum in the protective overlayer (see paragraph 6) can be substantially avoided. The presence of significant amounts of rhenium/tungsten/ruthenium, in combination with chromium, is critical to the specific objective of this invention. These refractory-type materials slow down diffusion, by restricting the solubility of aluminum in a higher-melting structured system. The barrier layer itself can also minimize the undesirable migration of various substrate elements into the protective coating, as described in the application.

Both of the applied references under 35 U.S.C. 103 have been described previously. The Examiner notes that Chech '635 teaches a protective coating having the composition described above, which includes, inter alia, 28-32 wt.% chromium, and 0-15 wt.% rhenium or tungsten. The absence of an overlying coating ("topcoat") like nickel aluminide or "MCrAlY" is also noted, and the Examiner mentions their presence in Spitsberg. The Examiner then states that it would have been obvious to one of ordinary skill in the art to apply the topcoats of Spitsberg to the protective coatings of Czech '635.

would also include the possibility of having Ni/Co/Fe and/or Al present (e.g., see claims 2 and 3, respectively). Moreover, component (b) of the claim is intended to cover the combination of tungsten with rhenium or ruthenium, or any combination thereof. Claim 5 has also been amended to properly depend from claim 48.

Claims 50-52 have been added to recite specific compositions preferred for some embodiments of the invention. Each claim utilizes the transitional term "consisting essentially of". However, it is the intention of the inventors that these claims may also include other components which do not substantially alter the properties of the compositions. Claim 50 is directed to compositions of Cr and at least one of Re/W/Ru. Claim 51 covers the subject matter of claim 50, in combination with at least one of Ni/Co/Fe. Finally, claim 52 embraces the subject matter of claim 51, in combination with at least one of the elements of component (d). (Those elements are described in paragraph 26 of the specification, second sentence). No new matter has been added by way of these new claims, and Applicant submits that they are novel and nonobvious in view of the cited references.

In conclusion, Applicant submits that the amended claims are now in allowable form, as are the new claims. The undersigned suggests that any remaining issues can be resolved by a telephone conference.

Respectfully submitted,

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"Marked-up" Version of Amended Claims,
Pursuant to 37 CFR 1.121c(1)(ii)

1. (amended) A barrier coating material, comprising:

(a) about 15 atom % to about 95 atom % chromium; and

(b) about [5] 15 atom % to about 60 atom % [of at least one element selected from the group consisting of] rhenium [, tungsten, ruthenium, and combinations thereof].

5. (amended) The barrier coating material of claim [1] 48, wherein the level of tungsten is in the range of about 5 atom % to about 20 atom %.

13. (amended) The barrier coating material of claim [1] 49, wherein the level of ruthenium is in the range of about 10 atom % to about 60 atom %.